CRUSER news / Issue 16 / June 2012

Issue 16 JUNE 2012

CRUSER • NEWS

Consortium for Robotics and Unmanned Systems Education and Research

FROM TECHNICAL TO ETHICAL...FROM CONCEPT GENERATION TO EXPERIMENTATION

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High Speed USVs for River Recon

by Eileen Baumann, VaCAS Public Relations, Virginia Tech

Virginia Tech's autonomous boat operating in the Pearl River in Mississippi

When a military force enters a river area controlled by the opposition, the danger increases tremendously. The enemy has the tactical advantage. There is little space to maneuver and it's hard to know what's around the bend or lurking in the water. Virginia Tech and Naval Postgraduate School (NPS) researchers have teamed up to address the challenge. They are developing unmanned surface vehicle (USV) technology to provide look-ahead capability, describing the river traffic, what and who lines the shore, and how navigable the river is up ahead. "These vehicles must be able to navigate autonomously in a dynamic and uncertain waterway, collect important environmental data, build a detailed map of the area, and acquire high-resolution imagery that can inform mission planning and execution," said Dan Stilwell of electrical and computer engineering. He and Craig Woolsey of aerospace and ocean engineering are leading the Virginia Tech team. "That's not easy on a river," Stilwell noted. River systems are full of unmapped, unpredictable hazards, which can vary from fallen trees, jutting rocks, and vehicle wreckage. Even high-resolution maps are usually not accurate enough to provide sufficient detail about shoreline positions and water depths. Plus, rivers change course and existing maps and charts may quickly become out of date. The USV also has to survive. "Speed is the main defense of such a vehicle," Woolsey explained. "This means the vehicle must employ sensing, planning and control algorithms that can be executed in real time, so the vehicle can move as fast as possible." The Virginia Tech/NPS team is developing technologies for the USV to sense the environment and detect hazards below the waterline, plus those observable from the surface. They are also developing algorithms for real-time, high-speed map building, obstacle avoidance, optimal path planning, and control of the USV. The group has split the development of the system: Virginia Tech has developed a test-bed USV that navigates using surface scanning, while NPS has developed a sonar-equipped USV that can avoid under-water obstacles. Virginia Tech's USV is a rigid hull inflatable boat that has been modified for autonomous and remotely controlled operations. The USV uses a laser line scanner to collect data on and above the surface of the river. The system then combines the laser line scanner data with existing incomplete map data to generate an accurate real-time map to use for navigation. The map is used to compute a safe path using a novel road-map based method, which can efficiently plan paths even though the area of operations may be extremely large. The planned path is guaranteed to be dynamically feasible for the USV to follow.

The NPS team, from the Center for Autonomous Vehicle Research (CAVR), operates a SeaFox USV, which is an aluminum hulled, rigid inflatable boat. Doug Horner, Sean Kragelund and Tad Masek are leading the effort there. They have adapted forward-looking imaging sonar, developed for underwater vehicles, to the SeaFox for building accurate maps below the waterline. The NPS team is also developing a fully configurable "Helmsman's Assist" graphical interface for boat operators, thus extending the navigation technology to manned surface vehicles. The interface provides real-time information about the environment in the vicinity of the vehicle, as well as paths that should be followed for safe navigation. This allows operation of manned surface vehicles under very low to no visibility conditions.

Not only do Virginia Tech and NPS share sensor systems, but they have also integrated software and algorithms. "The overall systems integration task was challenging, but Virginia Tech and NPS researchers have a history of productive collaboration," Stilwell noted. During 2011, Virginia Tech integrated their technology onto the SeaFox USV and performed a successful demonstration in Mississippi's Pearl River. The SeaFox USV was able to mark and avoid several hazardous areas that were not marked on its initial map, including some unanticipated boat traffic. During early 2012, Virginia Tech and NPS demonstrated long range autonomous operation on the Pearl River using Virginia Tech's USV. The effort is sponsored by the Office of Naval Research.

Director's Corner

The American physicist Richard P. Feynman once said "For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled" CRUSER's role is to explore what is possible in unmanned systems technologies, and then apply them to the practical world of defense operations. We accomplish this through our concept generation, technical exploration, and field experimentation mission thread. You will see these events throughout the year and the consortium is invited to contribute.

CAPT Jeff Kline, USN ret
CRUSER Director

Students Learn about World War II Shipwrecks at MATE Center's Annual Robotics Competition: Underwater robots help students assess and remediate simulated shipwrecks

by Caroline Brown, PR for MATE and Jill Zande, Associate Director, & Competition Coordinator, MATE Center, VP of Education and Research, Marine Technology Society

Underwater robots will invade Orlando when the Marine Advanced Technology Education (MATE) Center hosts its 11th Annual International Student ROV Competition at Orlando's YMCA Aquatic and Family Center from June 21-23. Student teams from all over the world will gather to compete with underwater robots, also known as remotely operated vehicles (ROVs), that they designed and built. The competition will be streamed live on the Internet at www.materover.org.

ROVs are tethered underwater robots used to complete tasks in deepwater environments. Each year, MATE's ROV competition encourages students to learn and apply science, technology, engineering, and math skills to complete tasks that simulate real-world problems from the ocean workplace. This year, the contest focuses on the role that ROVs play in assessing World War II shipwrecks and the potentially hazardous fuel oil that they may still contain.

The competition encourages students to think like entrepreneurs. Students are asked to transform their teams into "companies" that respond to a fictional RFP (request for proposal) for developing an ROV help with shipwreck documentation and remediation. During the process, the students develop the teamwork, creative thinking, and problem solving skills that make them competitive in today's global workplace.

Teams will participate in mission tasks, piloting their ROVs to assess the condition of a simulated shipwreck and determine a course of action if oil is still on board. In addition, they must prepare an engineering report, make a presentation to a panel of judges who represent various aspects of the marine industry, and create a poster display. Each team is evaluated on the design, construction, and performance of its ROV; the members' ability to communicate what they learned; and how they put their knowledge to use in designing and building their ROV.

Before the June event, teams from across the world participated in MATE's network of regional contests that feed into the international event. Currently, 21 regional competitions are part of the MATE Center's network:

- Big Island (Hilo, Hawai'i)
- Carolinas (Myrtle Beach, South Carolina)
- Egypt (Alexandria, Egypt)
- Florida (Cocoa, Florida)
- Great Lakes (Alpena, Michigan)
- Hawaii (Oahu, Hawai'i)
- Hong Kong (Hong Kong)
- Japan (Tokyo, Japan)
- Mid-Atlantic (Norfolk, Virginia)
- Monterey Bay (Monterey, California)
- New England (Buzzards Bay, Massachusetts)
- Newfoundland & Labrador (St. John's, Newfoundland and Labrador)
- Nova Scotia (Halifax, Nova Scotia)
- Pacific Northwest (Seattle, Washington)
- Pennsylvania (Villanova, Pennsylvania)
- Scotland (Aberdeen, Scotland)
- Midwest (Chicago, Illinois)
- Southern California Fly-Off (San Diego, California)
- Southeast (Savannah, Georgia)
- Texas (Houston, Texas)
- Wisconsin (Milwaukee, Wisconsin)

Organized by MATE and the Marine Technology Society's (MTS) ROV Committee, the ROV competition is designed to present middle school, high school, community college, and university students with the same types of challenges faced by scientists and engineers when working underwater, and to encourage them to learn and apply science, technology, engineering, and math skills to the real-world ocean workplace. The competition is supported by the Marine Technology Society ROV Committee, the National Science Foundation, NASA, NOAA, Oceaneering, and other ocean- and science-related organizations.

UNMANNED TECHNOLOGIES ASSESSED IN NAVY'S TRIDENT WARRIOR

by Terrance J. McKearney, President of The Ranger Group, http://www.therangergroup.com

TRIDENT WARRIOR, the Navy's principal experiment for the assessment of new C4ISR technology, has provided a backdrop for the evaluation of new and developing unmanned systems for several years. A dedicated at-sea period featuring operational naval forces acting as experimentation platforms for new technologies, this year's TRIDENT WARRIOR will include forces transiting from San Diego to Hawaii. This year's TRIDENT WARRIOR will feature experiments with surface and air unmanned systems across a range of missions. These include mine counter measures, surveillance and force protection. Some of the experiments will conclude during the multi-national RIMPAC exercise in July in the Hawaiian operating areas.

As a member of the TRIDENT WARRIOR Data Collection and Analysis Working Group (DAWG), CRUSER member and San Diego–based The Ranger Group has been a longstanding participant in TRIDENT WARRIOR and so has had the opportunity to learn and explore UAV experimentation. For example, in TRIDENT WARRIOR 10, TRG participated in data collection of a SEAL-delivered covert UAV launcher. The experiment identified that some "switchology" that needed to be improved for subsequent experiments. TRG also got the chance to preflight and operate a Maverick UAV during trials of the prototype on Oahu, HI. The Maverick is built by Prioria and was participating in one of the TRIDENT WARRIOR 10 experiments.

TRIDENT WARRIOR analyst Castle Phelps of The Ranger Group holds a Maverick UAV being evaluated as part of TRIDENT WARRIOR 10 at Dillingham Field on Oahu, HI. TRIDENT WARRIOR is the Navy's primary fleet level experiment for C4ISR initiatives and experiments with a range of unmanned systems.

Presentations from the CRUSER Technical Continuum (held in conjunction with the 10th International Mine Warfare Symposium) authorized for release are on the website http://www.10thsymposium.com

Joint Interagency Field Exploration Call for Papers

Since 2002, NPS field experimentation events have been conducted such that maximum innovation and collaboration are encouraged between DoD, government agencies, industry, universities, and in which SOF, National Guard, and first responder participation and feedback are utilized for effectiveness, affordability, and feasibility of future capabilities.

The success the NPS field experimentation events such as TNT/CBE and RELIEF have led to the desire in OSD to have a COCOM focused version of these events. In response, a cooperative team including the Naval Postgraduate School, National Defense University, and representation from each Combatant Command and the Department of Homeland Security have assembled to address this need. This past February, a prototype Joint Interagency Field Exploration (JIFX) event was held 27 Feb - 2 August at NPS's facilities at Camp Roberts, CA. The event incorporated two existing conventional research threads as well as experiments selected from COCOM and interagency representation. Building on this success, the 12-4 JIFX event will occur 13-17 August 2012.

Attendance at JIFX is by invitation only. If you are interested in attending, please preview the RFI document on our webstie for White Paper submission instructions. White Papers are due no later than 13 July, 2012. If accepted, you will receive an email confirmation notifying you of your acceptance. Attendance as an observer is possible, but is reserved for government employees.

http://www.nps.edu/Academics/Schools/GSOIS/Departments/IS/Research/FX/JIFX/JIFX.html

NEW - Unmanned Systems Forum

by David J Cummins, Founder

We stand at the edge of a new era; one that will feature unmanned systems heavily, not just in the traditional military ISR/ISTAR role, but instead with new and exciting commercial applications. You may be a member of a large organization or the owner of a "one man band", but together we all have one unified goal, and that is to see success in this field.

Finally there is a forum location for us all to go to for unmanned discussion; sub-surface, land, sea, air and space. This forum will provide us somewhere to bounce thoughts and suggestions around. It will present the opportunity to advertise a conference or other similar events that may be of interest to us in the unmanned community. You may wish to talk business, tell some old war stories, or just chat to people with a similar interest.

Do you have something to contribute when it comes to future flight in segregated airspace, technology capabilities or operational scenarios? Or, like many others are you looking for answers?

All feedback is welcome, so go and have fun posting!

http:\\www.unmannedforums.com

STUDENT CORNER

Students: Systems Engineering Analysis Student Cohort 18B Project

Title: Tailorable Remote Unmanned Combat Craft

U.S. military and civilian vessels are critically vulnerable to asymmetric threats in littoral environments. Highly proliferated asymmetric weapons such as Anti-Ship Cruise Missiles (ASCM), Low Slow Flying (LSF) Aircraft And Fast Attack Craft (FAC)/Fast Inshore Attack Craft (FIAC) threaten U.S. strategic goals and can produce unacceptable losses of men and material. These threats weigh heavily in the strategy calculus for the Anti-Access/Area Denial (A2AD) environment.

The SEA-18B team presented an operational concept and Technology/Capability Roadmap for a family of USVs capable of defending ships from air and surface asymmetric swarm attacks in the littoral domain. By developing the Tailorable Remote Unmanned Combat Craft (TRUCC) in concert with the next generation of capital surface vessels, the TRUCC fleet is shown to be a highly effective force multiplier. The potential employment of TRUCCs provides force protection in choke points, straits and high-threat areas worldwide, allowing manned capital ships to continue critical blue-water missions. Open architecture and common interfaces permit various configurations of the TRUCCs as delineated by a variety of threat mixes regardless of Area of Operations (AOR), and accommodate future sensor, communications and weapons capabilities.

The critical performance criteria of the TRUCC family are determined through Model-Based Systems Engineering (MBSE). Agent-based simulation analysis coupled with a Straits of Hormuz Multi-Threat Force Protection Design Reference Mission (DRM) reveal the most important criteria for TRUCCs in the force protection role. These major design criteria were force ratio (number of TRUCCs relative to attackers), TRUCC weapon Probability of kill (Pk) and weapon firing rate. This output highlighted the important factors for USV development. Large numbers of lower-cost vessels will have more combat capability than a smaller number of larger vessels. Additionally, the need to have highly capable weapons on smaller ships points to the need for open architecture and common interfaces. This allows for increased weapon (and therefore TRUCC) capability as technology increases. Highly capable weapons on a (relatively) low technology TRUCC platform offer the greatest combat capability against asymmetric threats.

This report explores short-term investment opportunities for the following communities: Surface Warfare, Mine Warfare, USMC and amphibious forces. Issues relating to operational availability and reliability are also explored in depth.

The TRUCC operational concept fills a critical vulnerability gap and its employment will reduce combat risk to our most valuable maritime assets; our ships and personnel.

For additional information or a copy of the project report please contact LCDR Loren Jacobi at loren.jacobi@navy.mil

New Documents on the Unmanned Systems Guide - http://libguides.nps.edu/Unmanned

Recently Released RAND Report: Methodologies for Analyzing Remotely Piloted Aircraft in Future Roles and Missions - The U.S. Air Force's remotely piloted aircraft (RPAs) have played a significant role in current operations in southwest Asia. As the inventory of RPAs increases and new sensor technologies come online in the coming years, the Air Force has an opportunity to consider additional roles that RPAs might play. Thoughtful study into these possibilities will ensure that, when the Air Force employs RPAs, they will help fill capability gaps or augment existing capabilities in more-efficient or more-effective ways. This documented briefing describes a suite of tools developed by RAND Project AIR FORCE (PAF) to help the Air Force think through future roles for RPAs. The tools evaluate platform selection and concept of operations (CONOPS) development, sensor performance against various targets, weapon effects, environmental factors, platform survivability, computational processing of data, and exploitation of sensor products. The briefing also explains how the separate analysis in each of these areas feeds into a mission-level analysis, performed with PAF's Systems and CONOPS Operational Effectiveness Model, and a campaign-level analysis using PAF's Force Structure Effectiveness model. Use of these tools and models will help clarify how future RPAs can contribute to U.S. warfighting in cost-effective ways. The tools presented herein are additionally useful for examining the effectiveness of new capabilities more broadly; examining the effectiveness of new platforms in the context of the entire intelligence, surveillance, and reconnaissance (ISR) force posture; and evaluating the most cost-effective ISR force structure to meet future operational needs.

History of Autonomous Unmanned Systems R&D at the Johns Hopkins University, Applied Physics Laboratory (JHU-APL)